

Abstract to be submitted to NSMMS on 7 Jan 11:

Overview of C/C-SiC Composite Development for the Orion Launch Abort System

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Past and present efforts by the authors to further understanding of the ceramic matrix composite (CMC) material used in the valve components of the Orion Launch Abort System (LAS) Attitude Control Motor (ACM) will be presented. The LAS is designed to quickly lift the Orion Crew Exploration Vehicle (CEV) away from its launch vehicle in emergency abort scenarios. The ACM is a solid rocket motor which utilizes eight throttleable nozzles to maintain proper orientation of the CEV during abort operations. Launch abort systems have not been available for use by NASA on manned launches since the last Apollo-Saturn launch in 1975.

The CMC material, carbon-carbon/silicon-carbide (C/C-SiC), is manufactured by Fiber Materials, Inc. and consists of a rigid 4-directional carbon-fiber tow weave reinforced with a mixed carbon plus SiC matrix. Several valve and full system (8-valve) static motor tests have been conducted by the motor vendor. The culmination of these tests was the successful flight test of the Orion LAS Pad Abort One (PA-1) vehicle on May 6, 2010. Due to the fast pace of the LAS development program, NASA Marshall Space Flight Center assisted the LAS community by performing a series of material and component evaluations using fired hardware from valve and full-system development motor tests, and from the PA-1 flight ACM motor.

Information will be presented on the structure of the C/C-SiC material, as well as the efficacy of various non-destructive evaluation (NDE) techniques, including but not limited to: radiography, computed tomography, nanofocus computed tomography, and X-ray transmission microscopy. Examinations of the microstructure of the material via scanning electron microscopy and energy dispersive spectroscopy will also be discussed. The findings resulting from the subject effort are assisting the LAS Project in risk assessments and in possible modifications to the final ACM operational design.